

### REMARKS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 1-10 and 16-26 are currently pending. Claims 1-10 have been amended; Claims 11-15 have been canceled; and Claims 16-26 have been added by the present amendment. The changes and additions to the claims are supported by the originally filed specification and do not add new matter.

In the outstanding Office Action, the specification was objected to regarding various informalities; Claims 1-15 were rejected under 35 U.S.C. § 112, first paragraph, regarding the stiffness matrix shown in Figure 5B; Claims 1-15 were rejected 35 U.S.C. § 112, second paragraph, regarding questions of antecedent basis; Claims 1-15 were rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter; Claims 1, 3, 5, 6, 8, 10, 11, 13, and 15 were rejected under 35 U.S.C. § 102(b) as being anticipated by Yang et al. ("Simulation of T-Section Profile Ring Rolling by the 3-D Rigid-Plastic Finite Element Method") (hereinafter "the Yang et al. reference"); and Claims 4, 9, and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Yang reference in view of Davey at al. ("An Efficient Solution Method for Finite Element Ring Rolling Simulation") (hereinafter "the Davey et al. reference").<sup>1</sup>

In response to the objection to the specification, the specification has been amended to address the informalities noted in the Office Action. Accordingly, the objection to the specification is believed to have been overcome.

Applicants respectfully traverse the rejection of Claims 1-15 under 35 U.S.C. § 112, first paragraph. As shown in Figures 5A and 5B and as described on pages 15-17 of the specification, a modified, extended stiffness matrix  $K\beta$  can be constructed to incorporate the velocity boundary conditions based on the rate of increase of the radius  $r_v$ , the correction

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<sup>1</sup> Applicants note that Claims 2, 7, and 12 were not rejected based on prior art.

value  $c_v$  for the traverse velocity, and the angular velocity  $\omega$  by adding predetermined coefficients corresponding to those three variables to the stiffness matrix. In this way, using the method shown in Figure 1, the unbalanced force can be calculated. In this regard, Applicants note that page 3 of the outstanding Office Action asserts that the elements in section A shown in Figure 5B are zero. However, this is incorrect. As disclosed on page 15 of the specification, the stiffness matrix K forms a distribution A of a diagonal zone having a predetermined width and non-zero elements concentrated near the main diagonal line, thus constructing a symmetrical band matrix. In an embodiment of the present invention, the first and  $n^{\text{th}}$  degrees of freedom correspond to the imaginary cutting plane, and these degrees of freedom are expressed by a linear combination of three variables. Since the degrees of freedom corresponding to the imaginary cutting planes (elements  $a_{11}$  and  $a_{nn}$  in Figure 5A) are converted to the three variables, these degrees of freedom are excluded from the subject of the solution and zeros are set in elements of Figure 5B that correspond to the elements  $a_{11}$  and  $a_{nn}$  of Figure 5A. Thus, for the degrees of freedom that do not correspond to the imaginary cutting plane, non-zero coefficients are set in the same manner as shown in Figure 5A. Accordingly, Applicants respectfully traverse the rejection of claims under 35 U.S.C. § 112, first paragraph.

Applicants respectfully submit that the rejections of the claims under 35 U.S.C. § 112, second paragraph, are rendered moot by the present amendment to the claims. Claims 1-10 have been amended to address the questions of antecedent basis and indefiniteness noted in the Office Action. Further, Applicants submit that the rejections of Claims 11-15 are rendered by the present cancellation of those claims.

Applicants respectfully submit that the rejections of the claims under 35 U.S.C. § 101 are rendered moot by the present amendment to the claims. Claim 1 has been amended to be directed to a computer-implemented numerical simulation method, while Claims 11-15 have been canceled. Further, Applicants note that independent Claim 6 has been amended to be

directed to a recording medium recorded with a computer program for making a computer function as a fixed axis of rotation time conversion section, by performing a series of steps. Thus, Applicants respectfully submit that none of the claims can be practiced with “pencil and paper,” as asserted in the Office Action. Accordingly, Applicants respectfully submit that the amended claims are directed to statutory subject matter.

Amended Claim 1 is directed to a computer-implemented numerical simulation method for rotary metal forming, comprising: (1) dividing, into a plurality of finite elements, a predetermined model zone between imaginary cutting planes intersecting with a circumferential direction in a rotary formed body rotated about an axis of rotation; (2) setting velocity boundary conditions of the imaginary cutting planes for the predetermined model zone by a function, wherein an angular velocity rotation about the axis rotation of the rotary formed body is variable and the velocity boundary conditions are set so as to model plastic deformation of the rotary form body in the circumferential direction; and (3) analyzing, by a finite element method, a forming process that continuously produces plastic deformation by localized contact with the rotary formed body. Claim 1 has been amended to clarify that the velocity boundary conditions are set so as to model plastic deformation of the rotary formed body in the circumferential direction. The changes to Claim 1 are supported by the originally filed specification and do not add new matter.<sup>2</sup> Without limiting the claims, some of the advantages of the invention recited in amended Claim 1 are set forth on page 4, last paragraph, to page 5, second paragraph.

Applicants respectfully submit that the rejection of Claim 1 (and dependent Claims 3 and 5) as anticipated by the Yang et al. reference are rendered moot by the present amendment to Claim 1.

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<sup>2</sup> See, e.g., page 29 of the specification.

The Yang et al. reference is directed to a three-dimensional rigid-plastic finite element method used to simulate the ring rolling of a T-shape section from an initially rectangular cross-section. However, the Yang et al. reference discloses that only the axial component of the frictional stress at the ring roll interfaces is taken into account and that all other components are ignored.<sup>3</sup> Moreover, Applicants respectfully submit that the Yang et al. references fails to disclose setting velocity boundary conditions so as to model plastic deformation of the rotary formed body in the circumferential direction, as recited in amended Claim 1. In this regard, Applicants note that the present specification discusses the Yang et al. reference both in the Background section (page 3) and in the Description of the Preferred Embodiment section (pages 29 and 30). In this regard, the specification clearly points out that the Yang et al. reference makes certain assumptions and sets the velocity boundary conditions such that it is not possible to reproduce plastic deformation when the rotary form body elongates in the circumferential direction.<sup>4</sup> Thus, the Yang et al. reference does not model plastic deformation of the rotary form body in the circumferential direction, as recited in amended Claim 1. Accordingly, Applicants respectfully submit that the amended Claim 1 patentably defines over the Yang et al. reference.

Further, Applicants note that dependent Claim 2 clarifies that the velocity boundary conditions are set equal to a function having three variables including the angular velocity for rotation about the axis of rotation of the rotary formed body, which is not disclosed by the Yang et al. reference.

Claim 6 recites limitations analogous to the limitations recited in amended Claim 1. Moreover, Claim 6 has been amended in a manner analogous to the amendment to Claim 1. Accordingly, for the reasons stated above for the patentability of Claim 1, Applicants

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<sup>3</sup> See page 543 of the Yang et al. reference.

<sup>4</sup> See also Yang et al., page 542, fourth paragraph; page 543, fifth and seventh paragraphs; page 544, last paragraph; and page 545, last paragraph.

respectfully submit that the rejection of Claim 6 (and dependent Claims 8 and 10) as anticipated by the Yang et al. reference is rendered moot by the present amendment to Claim 6.

Regarding the rejection of dependent Claims 4 and 9 under 35 U.S.C. § 103, Applicants respectfully submit that the Davey et al. reference fails to remedy the deficiencies of the Yang et al. reference, as discussed above. Accordingly, Applicant respectfully submit that the rejection of Claims 4 and 9 is rendered moot by the present amendment to independent Claims 1 and 6.

Applicants respectfully submit that the rejections of Claims 11-15 are rendered moot by the present cancellation of those claims.

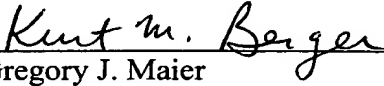
The present amendment also sets forth new dependent Claims 16-26 for examination on the merits. New Claims 16-25 recite limitations analogous to the limitations recited in Claims 3-5 and 8-10. New Claim 26, which depends from Claim 1, is supported, e.g., by page 4, last paragraph, to page 5, second paragraph; page 24, lines 9-11; and Figures 7A, 8A, and 9A. Accordingly, new Claims 16-26 are supported by the originally filed specification and do not add new matter. Moreover, based on the asserted allowability of Claims 1-10, Applicants respectfully submit that new Claims 16-26 patentably define over any proper combination of the Yang et al. reference and the Davey et al. reference.

Thus, it is respectfully submitted that independent Claims 1, 6, and 16 (and all associated dependent claims) patentably define over any proper combination of the Yang et al. reference and the Davey et al. reference.

Consequently, in view of the present amendment and in light of the above discussion, the outstanding grounds for rejection are believed to have been overcome the application as amended herewith is believed to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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